(12) UK Patent Application (19) GB (11) 2 119 303 A

(21) Application No 8309985
(22) Date of filing 31 Mar 1983
(30) Priority data
(31) 8209971
(32) 3 Apr 1982
(33) United Kingdom (GB)
(43) Application published
16 Nov 1983
(51) INT CL³
B29C 1/00
(52) Domestic classification
B5A 1R214G 1R214H
1R314C3 1R400 2079
2E1E M5C
U1S 1839 1854 B5A
(56) Documents cited
GB 1003037
GB 1003033
(58) Field of search
B5A
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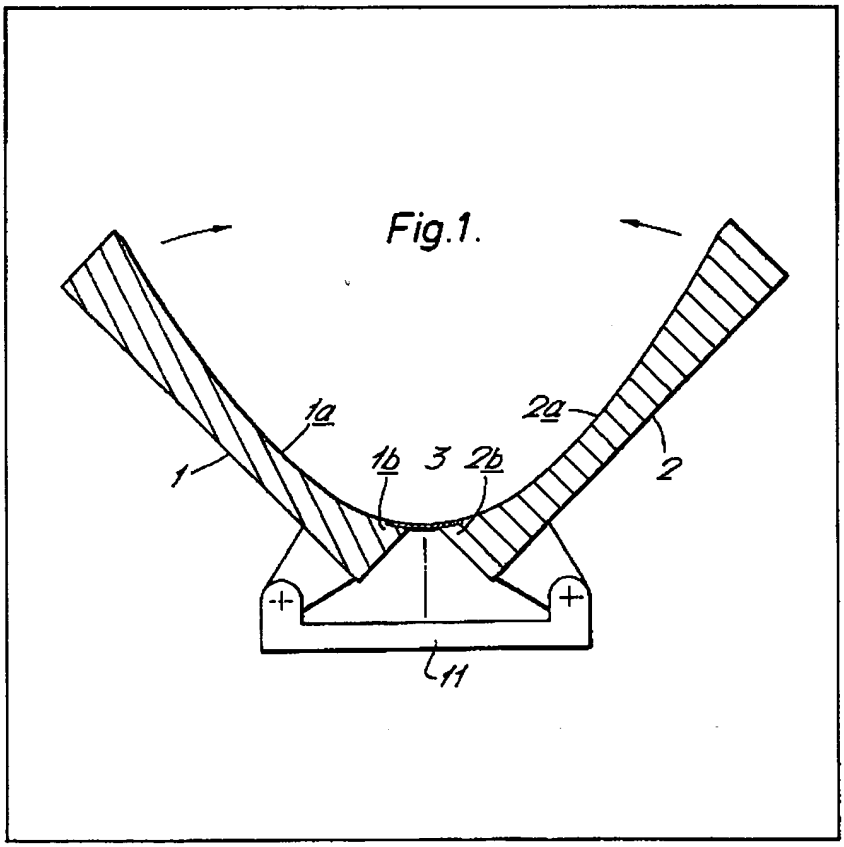
(54) **Mould**

(57) An aerofoil mould is described which consists of two mould parts 1, 2 hinged together by a flexible mould part 3. In use fibre-reinforced plastic material is laid up on surfaces 1a, 2a and on flexible mould part 3, inserts are incorporated if desired, the mould closed and the article cured.



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The drawings originally filed were informal and the print here reproduced is taken from a later filed formal copy.

Fig.1.

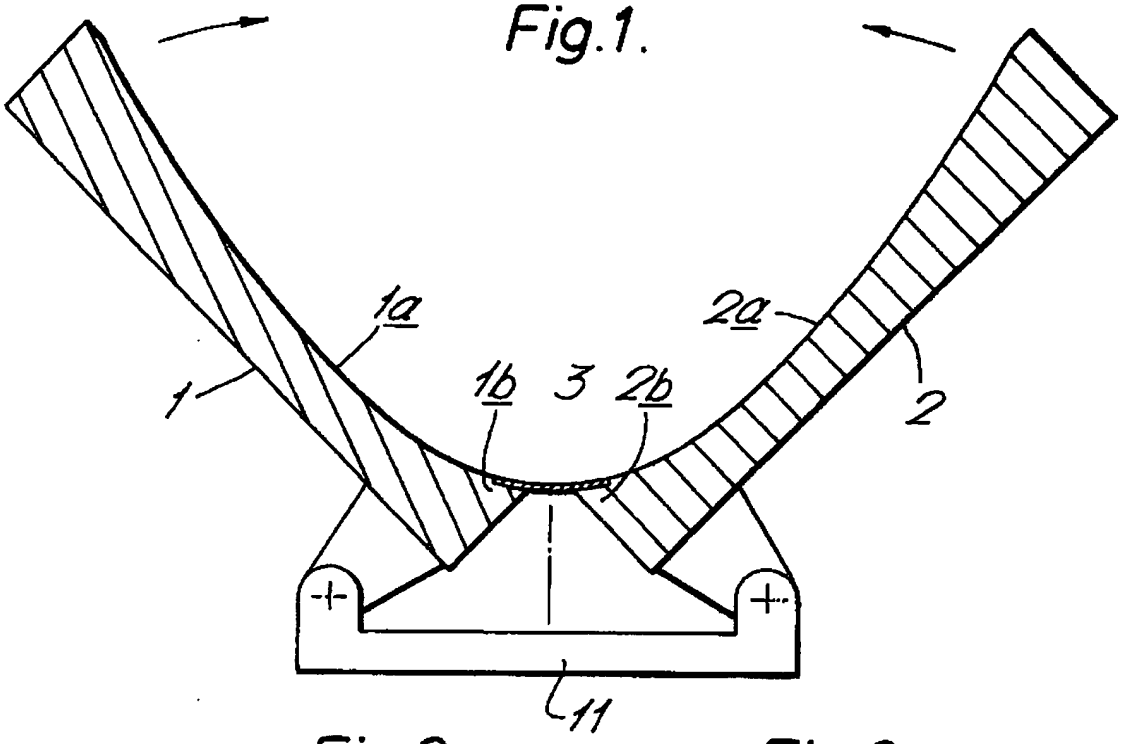


Fig.2.

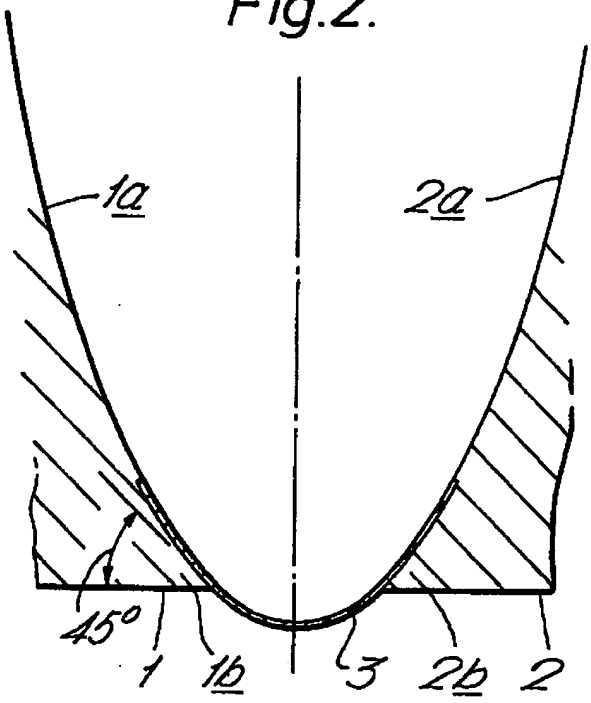


Fig.3.

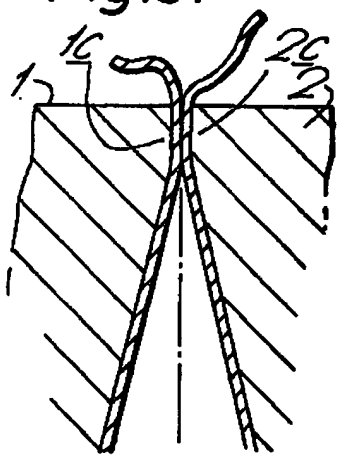


Fig.4.

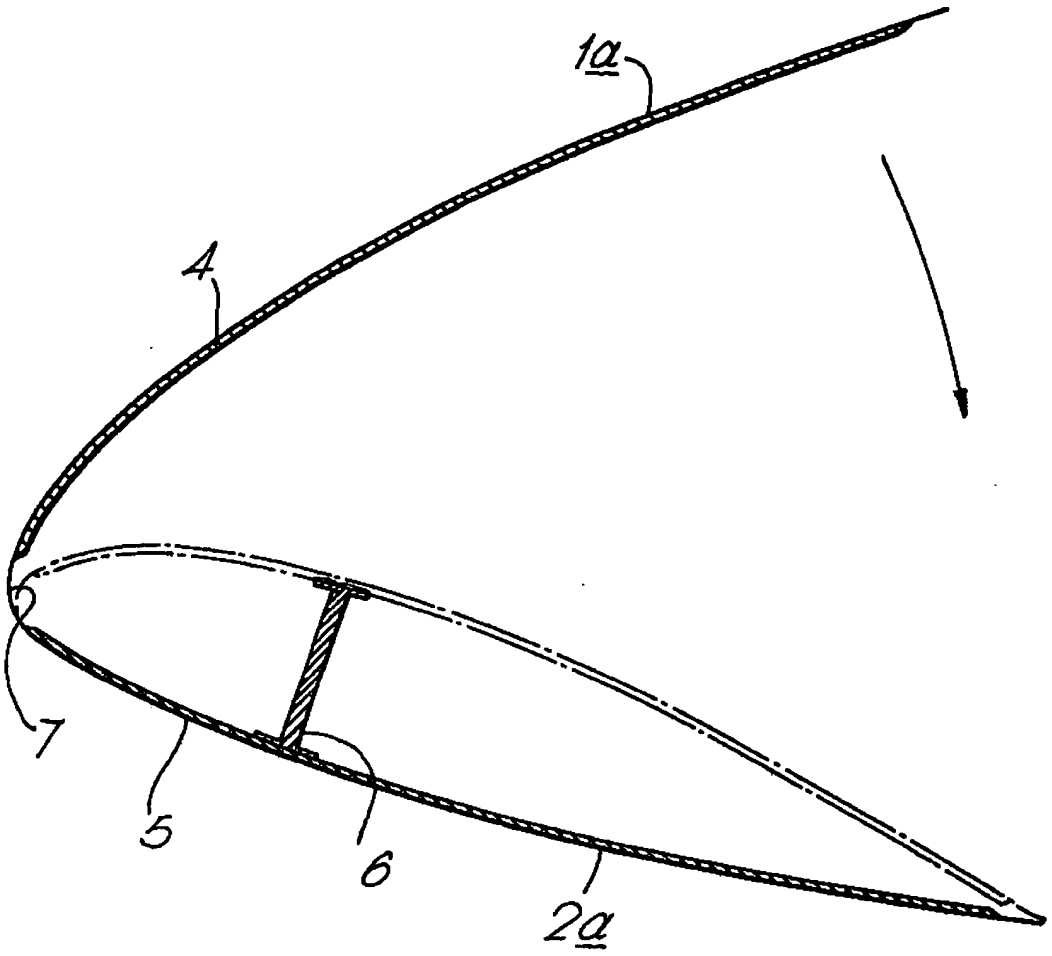


Fig.5.

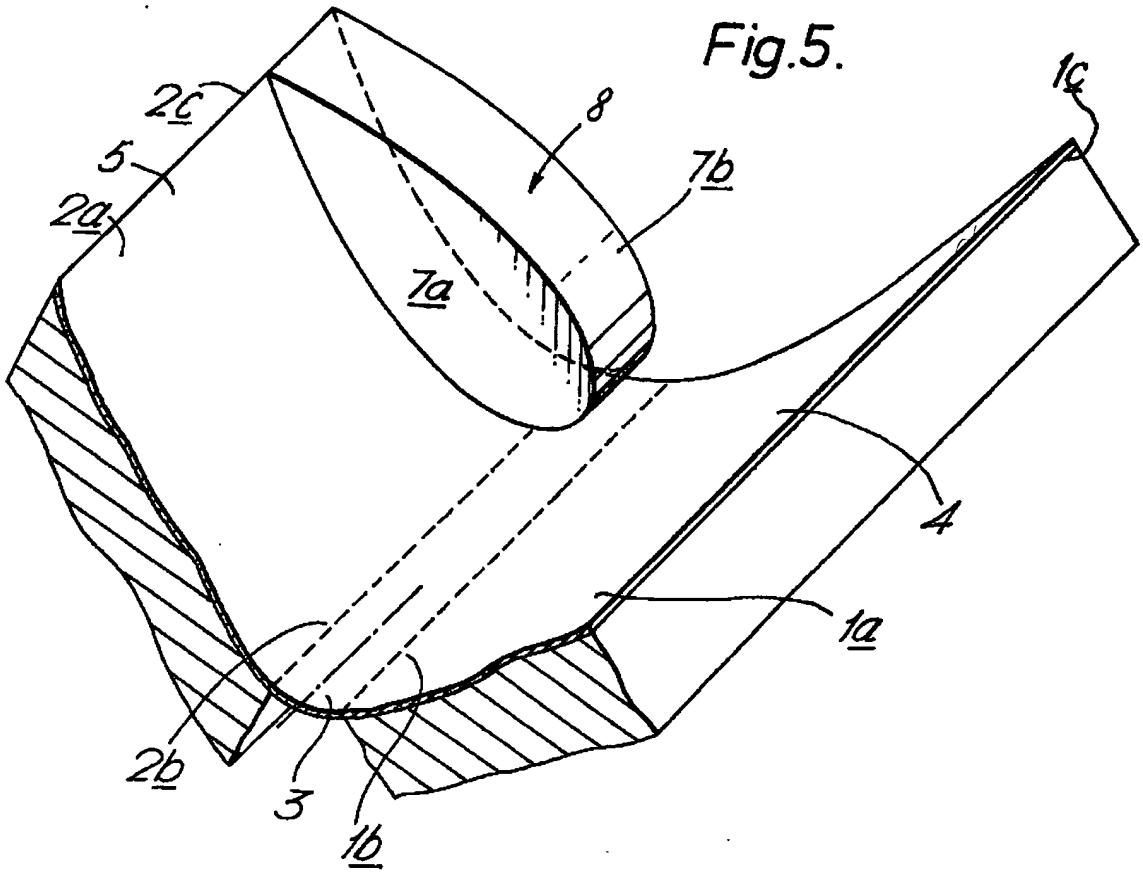


Fig.6.

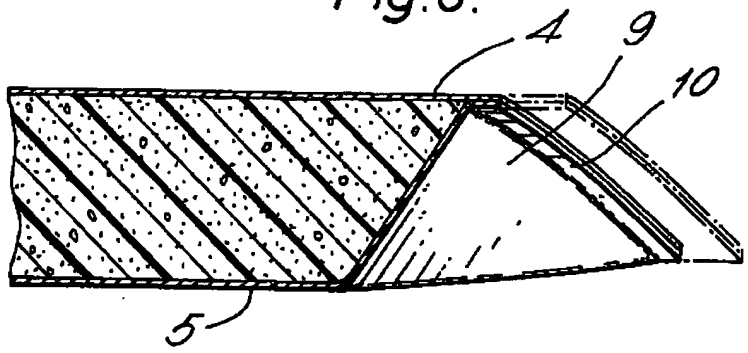


Fig.7.

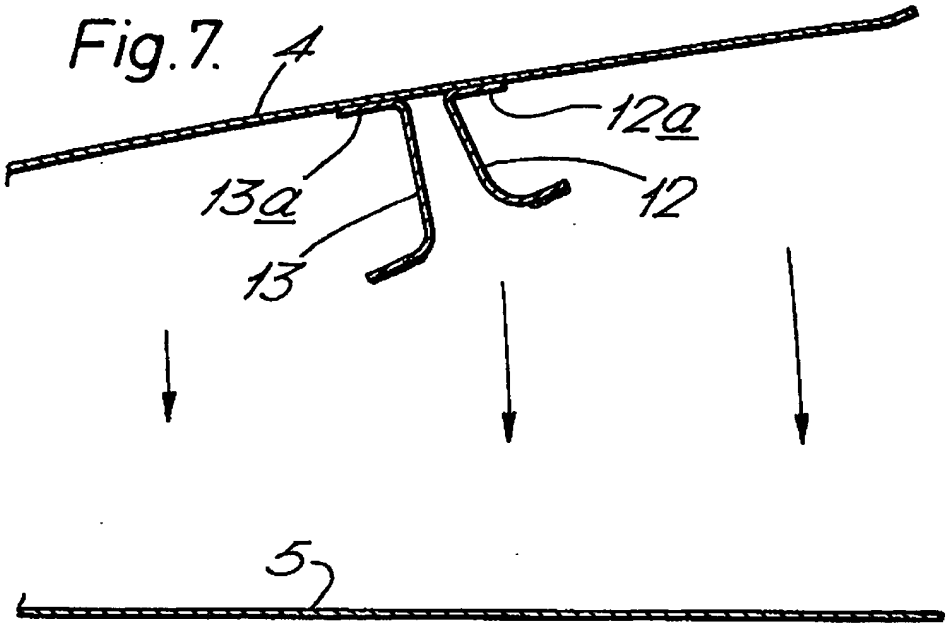


Fig.8.

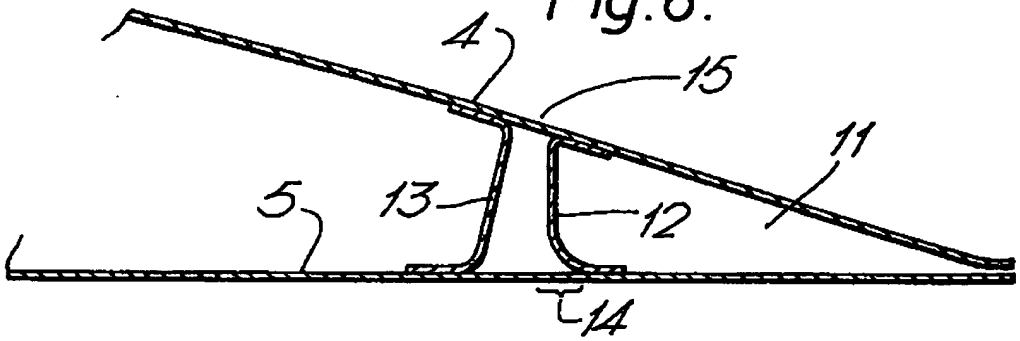
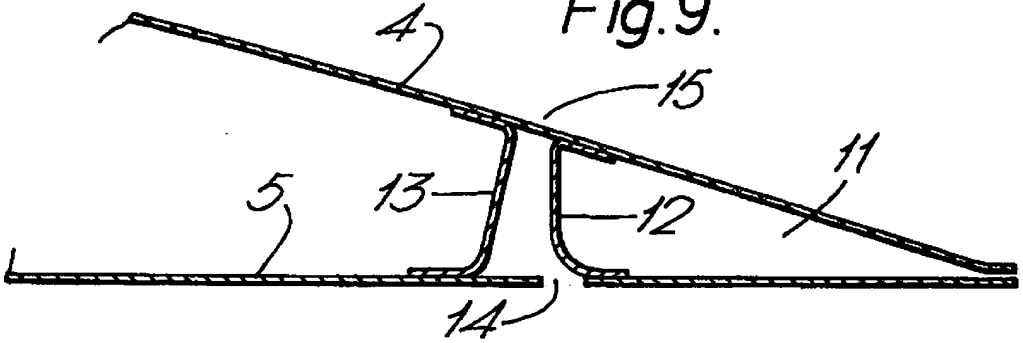


Fig.9.



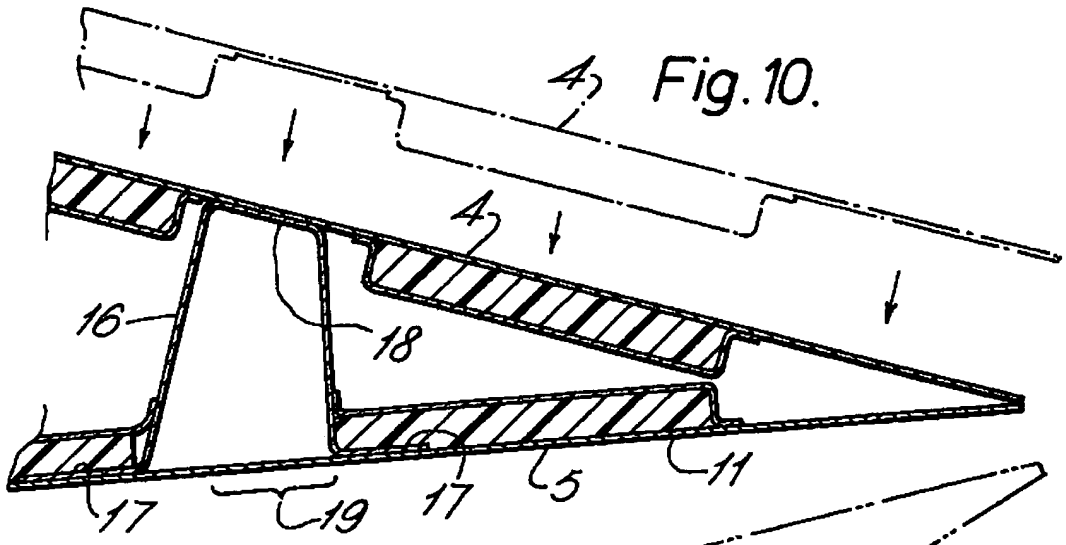


Fig.10.

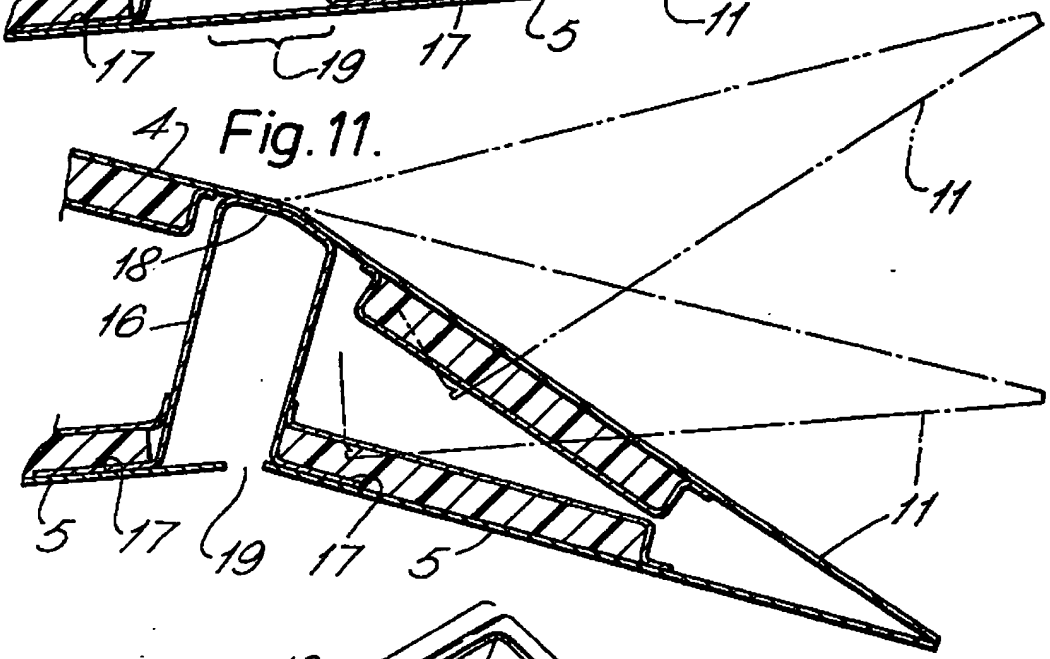


Fig.11.

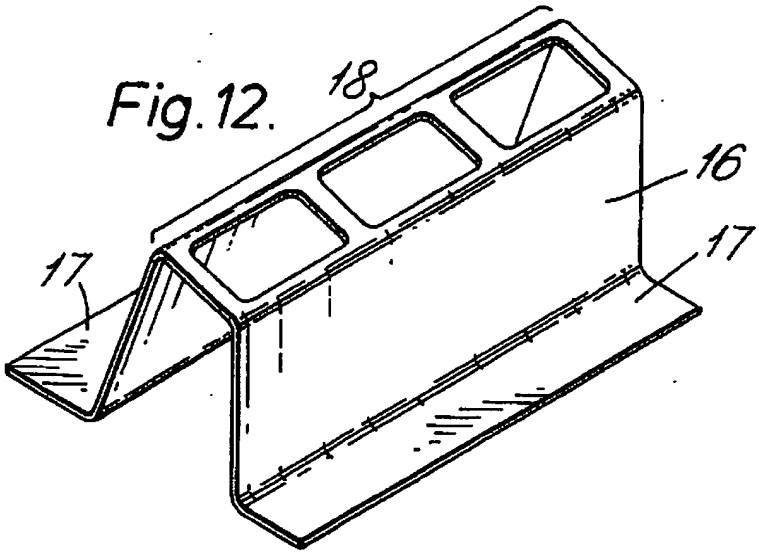


Fig.12.

SPECIFICATION

Mould

This invention relates to moulds for forming plastics composite products. Where such composite products have two surface regions lying in oppositely facing relatively closely spaced relationship joined at adjacent edges by a further region, access to the interior of a mould to effect layup can be difficult unless the mould has separable components. This problem is exemplified by the case of an aerofoil member which has an upper surface and a lower surface joined by a leading edge region; naturally, the upper and lower surfaces may be relatively closely spaced.

An object of the present invention is to provide a mould in which the layup of such composite products is facilitated.

According to one aspect of the invention, a mould, for forming plastics composite products having two surface regions which when formed lie in oppositely facing relationship and which are joined at adjacent edges by a joining region, includes two mould portions, each shaped to respectively form one of said surface regions of the product, the two mould portions being joined at adjacent edge regions by a flexible mould portion, which, when the mould is closed, assumes or is caused to assume a desired shape to form the joining region of the product but which allows the two mould portions to be swung apart.

By this arrangement access to the two mould portions can be facilitated for layup or product removal, whilst on closure, the desired mould shape is correctly assumed.

Preferably, those edges of the two laid-up surface regions of the product remote from the joining region are caused to abut by closure of the mould; in this case, although not necessarily exclusively, the space encompassed by the two surface regions and the joining region of the product is filled with a filling material.

One embodiment of a mould and a product formed by the mould is described with reference to the accompanying drawings in which:-

Figure 1 is a cross sectional view of a mould in an open position,

Figures 2 and *3* are enlarged details of two parts of the mould in a closed condition,

Figure 4 illustrates the construction of a product of the mould; in this case an aerofoil member,

Figures 5 and *6* illustrate a tip portion of the product of Figure 4,

Figure 7 is an enlarged view of a trailing edge region of an adaptation of the embodiment of Figure 4 to provide an aerodynamic control member,

Figure 8 is a similar view to that of Figure 7 but with the upper and lower surfaces joined to one another,

Figure 9 is a similar view to that of Figure 8 but with a region of the lower surface removed,

Figure 10 is a combined view similar to those of Figures 7 and 8, the upper surface being shown in two positions, but showing an alternative embodiment,

Figure 11 is a similar view to that of Figure 9 showing the alternative embodiment of Figure 10 and with a formed control member in various positions, and,

Figure 12 shows an element of the structure of Figures 10 and 11.

In the drawings a mould comprises a first mould portion 1 having an interior surface 1*a* shaped to form the exterior of, say, an upper surface of an aerofoil member, a second mould portion 2 having an interior surface 2*a* shaped to form the exterior of, say, a lower surface, and a flexible portion 3 joining adjacent edges 1*b* and 2*b* of the first and second mould portions.

The flexible portion 3 is sufficiently resilient to allow the portions 1 and 2 to be hinged apart to allow lay-up access to the interior surfaces 1*a*, 2*a* and the interior of the flexible portion 3, but when the mould is closed, as illustrated in Figure 2, to assume a concave form. A hinge member 11 is provided to interconnect the portions 1 and 2; its geometry being such to place the flexible portion 3 in tension or compression as the mould is closed and thereby increase or decrease the curvature of that part of the mould.

As illustrated in Figure 3, remote edges 1*c* and 2*c* of the mould portions are shaped to clamp laid-up material of the product together in the closed position, adhesive being applied to the adjacent faces of the laid-up material prior to mould closure.

By way of example, steges in forming a product in the mould of Figures 1 - 3, are illustrated with reference to Figure 4. With the mould in the position of Figure 1, and suitably supported, fibre reinforced plastics skins 4 and 5 are laid-up respectively on the surfaces 1*a* and 2*a*. As illustrated, these can comprise fibrous sheets sandwiching a core of foam, honeycomb, or balsa wood for example. If desired a preformed spar member or members 6 can be bonded to one skin during lay-up and to the further skin when the mould is closed. On completion of lay-up on the surfaces 1*a* and 2*a*, further lay-up 7 is effected on the interior of the flexible portion 3. This can be, for example, of chopped strand mat. The mould is closed while this lay-up (which will form the leading edge of the aerofoil) is sufficienty soft to follow the changing contour of the flexible portion 3.

Although unnecessary in the described embodiment, on mould closure the interior of the aerofoil, as encompassed by the skins 4 and 5 and the further lay-up 7 may be filled with a plastics foam or similar filling. Alternatively, this region can be pre-filled by a specially shaped filling positioned prior to closure.

In the aerofoil embodiment, where it is desirable to form an end region, for example a wing tip, a former 8 is attached to one mould portion say that referenced 2. The skin lay-up 5 is placed, with the mould open as illustrated in Figure 5, continuously along the surface 2*a*, over an inwardly facing surface 7*a* of the former 8 and subsequently over a surface thereof 7*a* which, when the mould is closed, will abut the opposed interior 1*a* respectively.

Figure 6 illustrates the end product, the formed surface 5 extending transversely across towards the

formed upper surface 4 and forming an end face 9, the end strip of which is bent outwardly at 10 in bonded abutting relationship to the formed upper surface 4.

Figures 7 to 9 illustrate the formation of a movable member 11 such as, for example, an aileron, flap, elevator or elevon during the moulding process. The formation of such a member is much facilitated by the previously described mould.

With the mould open, the reinforced plastics skin 4 is provided with twin channels 12 and 13 placed in back-to-back spaced relationship, their flanges 12*a*, 13*a* being adhered to the interior surface of the skin 4. Adhesive paste is placed upon those lower flanges 12*b*, 13*b* so that, on closure of the mould the paste, when cured, will bond these flanges to the lower skin 5. The mould closed position is shown in Figure 8.

Subsequent to curing, a spanwise extending slot 14 is formed in the lower skin 5 between the channels 13. Thus that region 15 of the upper skin 4 lying between the channels can form a flexible hinge.

Figures 10 - 12 show an alternative arrangement for forming a movable member 11.

With the mould open, the lower skin 5 is provided with a channel sectioned element 16 (Figure 12) which has outspread flanges 17; these flanges being adhered to the interior surface of the lower skin 5. That region 18 of the channel element 16, which when the mould is closed, will abut and be adhered to the interior surface of the upper skin 4, is formed either of very thin material or, as illustrated, suitably formed with apertures to give flexibility.

On closure of the mould the upper skin is moved from the position shown in broken outline in Figure 10 to the position shown in hard outline, the region 18 of the channel abutting and being bonded to the inner surface of the upper skin 5.

Subsequently, a spanwise region 19 of the lower skin 5 is removed, allowing the member 11 to pivot about that region of the upper skin adjacent the region 18 as shown in Figure 11.

By the described arrangement the necessity for accurate location of separately formed components of the product, e.g. upper and lower aerofoil surfaces, when assembling prior to bonding together is eliminated. Thus expensive jigs and tools are unnecessary.

CLAIMS

1. A mould for forming plastics composite products having two surface regions which when formed lie in oppositely facing relationship and which are joined at adjacent edges by a joining region, includes two mould portions, each shaped to respectively form one of said surface regions of the product, the two mould portions being joined at adjacent edge regions by a flexible mould portion, which, when the mould is closed, assumes or is caused to assume a desired shape to form the joining region of the product but which allows the two mould portions to be swung apart.

2. A mould according to Claim 1, wherein said two mould portions are interconnected by hinge means of a geometry such as to stress the flexible mould portion as said two mould portions are swung together to thereby effect a desired curvature of the flexible portion.

3. A mould according to Claim 1 or Claim 2, adapted for forming an aerofoil wherein said two mould portions are shaped to form the respective upper and lower surface regions of the aerofoil and the flexible mould portion is shaped, on closure of the mould, to form a leading edge region.

4. A mould according to Claim 3, wherein said two mould members abut on closure of the mould to form a trailing edge region of the aerofoil.

5. A method of forming an aerofoil using the mould of any of the previous Claims including the steps of, with the mould open, laying-up a upper skin on one of said two mould portions, laying-up a lowr skin on the other of said two mould portions, laying-up a leading edge skin upon the flexible portion, placing reinforcing members, as necessary, between the two skins for bonding thereto, and closing the mould whilst at least the leading edge skin is still flexible for curing.

6. A method according to Claim 5 when dependent upon Claim 4 including the step of positioning trailing regions of the upper and lower skins so as to become clamped and bonded one to the other between the abutting regions of said two mould members and thereby form a trailing edge region of the aerofoil.

7. A method according to Claims 5 or 6, including the step, subsequent to removal from the mould, of removing a generally spanwise portion of one of the skins adjacent a reinforcing member to provide a movable portion flexing about a spanwise portion of the other of said skins.

8. A mould substantially as described with reference to the accompanying drawings.

9. An aerofoil substantially as produced by the method of any one of Claims 5 - 7.

Printed for Her Majesty's Stationary Office, by Croydon Printing Company Limited, Croydon, Surrey, 1983.
Published by The Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.